

*Hasora hobroa*, nov.

♂. Palpi, head, and thorax green; abdomen pale brown, its basal half covered with dull green hairs; antennæ black; wings olive-brown, paling towards base with an ochreous tinge; a green patch on the costa of fore wings one third from the base; a slight greenish-grey suffusion below costa at the base; the hind wings with the basal and abdominal areas covered with greenish-grey hairs; cilia brown, with pale tips; wings without any other markings. Underside: wings paler and suffused with ochreous; fore wings with the apical and outer marginal spaces darkest; hind wings with a broad pale discal shade, the wing dark on both sides of it and merging into blackish in and above the anal lobe, which is much restricted; cilia with a white short basal line above the anal line; pectus and body grey tinged with green; legs darker green.

Expanse of wings  $2\frac{2}{10}$  inches.

Celebes (type in B. M.).

The fore wings are shorter than usual and the hind wings are very deep and round, and it has no stigma.

*Hasora meala*, nov.

♂. Palpi below and a ring round the eyes ochreous grey; head, body, and wings olive-brown, as in *chromus*, (Gram.); cilia brown; wings without markings; wings below paler and with a gloss on them; fore wings with the costa broadly smeared with blue-green above the cell, a short dark transverse shade beyond the end: hind wings with a thin, straight, transverse white band or thick line from the costa a little before the apex to the abdominal margin one fifth from the anal angle, the whole space inside this line blue-green; anal lobe damaged on both wings, but is evidently much restricted and has a blackish patch; face, pectus, and entire body brown; legs ochreous grey.

Expanse of wings  $2\frac{1}{10}$  inches.

Celebes (*Wallace*) (type in B. M.).

A good and distinct species.

LXII.—*The Significance of the Pattern of the Cubs of Lions (Felis leo) and of Pumas (Felis concolor)*. By R. I. Pocock, F.L.S., F.Z.S., Superintendent of the Zoological Society's Gardens.

[Plates XIX. & XX.]

As a very general, perhaps invariable, rule, members of the cat tribe (*Felis*) that are spotted or striped when adult are

similarly spotted or striped when young—that is to say, the pattern undergoes no very marked change with growth, apart from gaining or losing in distinctness. Even when it is evanescent in the adult, such indications of it as are preserved coincide with the more clearly defined pattern of the cub or kitten. It is therefore permissible to conclude that those species in which the adult is self-coloured and the cub variegated were marked as their cubs are marked and in no other way. Hence the pattern of the cub must be treated as a specific character, and may be regarded as affording a most useful clue to affinity. Possibly, indeed, the true relationships of some of the self-coloured species of *Felis* will never be certainly ascertained until the pattern of the foetal or newly born young is known.

It is in the truth of the above-stated propositions that lie the chief interest and importance of the pattern exhibited by the cubs of lions and pumas.

It is well known that the newly born cubs of those species show a definite pattern of dark marks upon a tawny or pale brown ground-colour; but although the presence of this pattern has been cited repeatedly as evidence of the descent of the species concerned from striped or spotted ancestors, I am not aware that it has been used previously as a guide in determining their affinities with other existing forms of the genus *Felis*.

Examination of a series of skins of lion cubs shows that the pattern, which has been described sometimes as “spots,” sometimes as “stripes,” varies considerably in intensity with individuals. The meaning of this variation is unknown to me, since all the skins I have seen belong to specimens born in menageries from parents of unknown geographical origin. Sportsmen and collectors, unaware of the interest of the question, have never apparently brought skins of wild-born cubs from different localities. There are therefore no data from which an opinion can be formed as to the local constancy of the coloration of the cubs and of the value of the variation, if any, in taxonomy.

One of the best-marked examples I have seen was born at the Clifton Zoological Gardens in the spring of 1904 and is preserved in the Bristol Museum. An account of it was published\* by Mr. Herbert Bolton, F.R.S.E., F.Z.S., the curator; and I am indebted to him for kindly lending me this and one other specimen for examination and description †.

\* Proc. Bristol Society, (2) x. pp. 248–249 (1904).

† I have also seen other specimens in the Bristol Museum and in the Museum of the Zoological Gardens at Clifton, where they were bred.

The ground-colour is a sandy or in parts a golden yellow fading to white on the lips, the chin, the interramal area, the chest, the posterior part of the belly, and the inner side of the limbs. The underside of the tail is also whitish in the middle line; but the throat and the median part of the belly are washed with yellow. There is a conspicuous and rather large whitish patch over the inner half of the eye. The back of the ears is jet-black with a narrow edging of white. The pattern, which consists for the most part of spots, is so abundant and diffused that the interspaces look like pale stripes on a dark ground. The spots are rosette-spots like those of an ounce, an Indian leopard, or a jaguar—that is to say, they consist of a black or dusky brown more or less broken up rim surrounding an area which, though much lighter than the rim, is decidedly darker than the intervening spaces. Everywhere on the body and on the upper portion of the limbs the spots are markedly wider than the interspaces. On the upper surface of the head and along the spine the spots are more heavily pigmented than elsewhere, except on the hind leg between the knee and the hock and on the distal end of the tail, where they are as black as on the back. On the head the spots run into six rather confused and broken up longitudinal stripes, two admedians mostly blended together, which pass backwards from above the eyes on to the nape of the neck, and two laterals on each side, which converge inwards over the occiput and fuse with the admedians on the fore part of the nape. The external of these rises just above the ear on each side; the internal rises much further forwards above the inner angle of the eye. As in the chitah (*Cynailurus jubatus*), there is a patch of pigment extending downwards from the inner angle of the eye to the white of the upper lip. There is also a patch of black pigment above the outer half of the eye, and the area of the cheek behind and below the eye is clouded with black. On the sides of the neck and shoulders the pattern is obscure, but where visible the spots show indications of transverse or vertical arrangement. This transverse arrangement is very clearly expressed upon the body, especially upon its thoracic portion, where the spots are most manifestly transversely or vertically elongated and not subcircular as in leopards (*F. pardus*) and jaguars (*F. onca*), nor longitudinally elongate

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Their coloration agrees substantially with that of the examples described above. None, however, are quite so heavily pigmented, though in some the tigrine nature of the pattern is equally strongly, if not more strongly, in evidence.

as in some ounces (*F. uncia*). They are, moreover, set end to end, one above the other, forming in some cases interrupted double wavy stripes from two to three inches long, extending from the median spinal line on to the belly. They might perhaps be described as transverse chains of spots comparable to the longitudinal chains of spots seen in ocelots (*F. pardalis*). The duplication of the stripes is formed by the fusion of the anterior rims of the superimposed rosettes and of the posterior rims of the rosettes, the two resulting streaks being separated by a paler area representing the fused central portions of the rosettes. In some cases these rosette-stripes extend uninterruptedly across the spine, meeting those of the opposite side at an obtuse angle and being divided from the preceding and succeeding rosette-stripes by the also uninterrupted narrow intervening strip of pale ground-colour.

On the right side of the body the fusion of the rosettes into lines is less pronounced than on the left side. On the spinal area where the rosettes are more heavily pigmented, the pale central area of each is less clearly shown than on the sides. On the sacral region and on the root of the tail the rosettes show a distinct arrangement in four longitudinal stripes, such as may be frequently seen in leopards, jaguars, and ounces. On the upper part of the thighs the arrangement of the rosettes is irregular, but on the lower and posterior parts a longitudinal arrangement with an upward angulation, such as is shown in a more emphatic manner in tigers, is noticeable. Above and below the hocks the spots are more solid and they extend on to the inner surface of the limb above the hock and halfway down the front of the leg between the hock and the paw. The paw is white and spotless. The fore legs are more tawny than the hind legs and are rather faintly rosetted from the elbow to the paw, but on the inner side below the elbow very decided indications of the brachial stripes so constant in cats are retained. The tail is spotted from the root to the tip, the spots, which are more strongly pronounced terminally, showing distinct transverse arrangement (Pl. XIX.).

The second cub, which is larger and probably older than the one just described, has the same style of pattern, but the pattern is everywhere much fainter, the backs of the ears being the only parts as heavily pigmented as in the other example. In both specimens the hair on the neck is directed backwards as in young tigers and leopards, and not forwards on the sides of the neck and forming a median cervical crest as is the case, at all events usually, in adult leopards and

tigers and also in adult lions. There are distinct signs of the whorl of hair on the shoulder\*.

It seems to me that the pattern of lion cubs affords very strong support to Dr. Bonavia's view respecting the origin of the stripes of the tiger from the fusion of rosette-spots, such as are seen in Asiatic leopards, into subvertical or obliquely transverse lines. In tigers the stripes are seldom quite vertical, except upon the upper part of the shoulders and hind-quarters. On the sides of the body beneath the lumbar region they are oblique with a decided dorso-ventral inclination backwards. Moreover, they seldom form continuous streaks. Quite commonly each is broken up into three constituents, a dorsal, a medio-lateral, and a ventral, which frequently overlap at their juxtaposed extremities. The medio-laterals are often suppressed on the thoracic area behind the shoulder, as may be seen in two specimens from Nepal now living in the Zoological Society's Gardens and in a "Siberian" specimen mounted in the British Museum. It is not unusual to see one or more of the above-mentioned constituent stripes continued by a row of faint spots; or there may be rows of such small spots on the interspaces between the stripes. Quite commonly, too, one or more of the constituent stripes may be doubled in the form of a long loop. More rarely where there is a greater degree of fusion between the constituents a continuous double stripe results; and these double stripes may, I think, be truthfully compared with what may be called the rosette-stripes of lion cubs, the anterior and posterior dark rims of the rosette-stripes in the lion corresponding respectively to the anterior and posterior moieties of the double or loop-stripe in the tiger. This, I understand, is substantially Dr. Bonavia's interpretation of the origin of the pattern in the tiger. He did not, however, cite the pattern of the lion cubs in support of his hypothesis, but depended upon that of leopards or jaguars, which supply less cogent evidence in its favour, because in these species the rosettes do not fuse into stripes as they do in lion cubs†.

\* On account of the erroneous belief held by some people that young lions are born with their eyes open, it may be added that the eyes in these two specimens, as in all others I have seen, are closed, as is the case, so far as I know, in all species of *Felis*.

† Although I have attempted to show that the pattern of lion cubs bears out Dr. Bonavia's views of the origin of stripes of tigers from rosette-spots such as are seen in jaguars, I do not agree with that author in believing that the pattern in *Felidae* was originally of that type. It must be admitted, I think, that Eimer was right in holding that the pattern in these animals consisted primarily of longitudinal stripes.

Another point in which the pattern of these lion cubs differs from the pattern of leopards, jaguars, and ounces, and approaches that of tigers is the following. In the three spotted species if the spots upon the spine show definite arrangement that arrangement is decidedly longitudinally linear. It is always so, I believe, more or less upon the sacral region, but less decidedly so on the lumbar and thoracic areas. In tigers, on the contrary, the upper extremities of the stripes almost invariably turn forwards on the spine, and meeting from opposite sides in the middle line at an angle form a series of  $\Lambda$ -shaped figures, a corresponding shape being naturally assumed by the intervening spaces. In the lion cub above described a similar pattern is quite clearly indicated in certain places, the spine being crossed from right to left by broad irregular  $\Lambda$ -shaped blotchy stripes separated by narrower interspaces of a golden-tawny hue. In tigers, of course, the interspaces are wider than the stripes, the converse being true of the lion. This circumstance is quite in keeping with the theory that the narrow stripes of the tiger resulted from the antero-posterior compression of the broader rosette-stripes such as are seen in young lions.

On the tail and lower half of the thigh, as stated above, the disposition of the spots in the lion cub also foreshadows the stripes of these regions seen in tigers, but not seen, or not nearly so clearly seen, in leopards, jaguars, and ounces.

Another truly tigrine feature is the presence of a white patch over each eye. This is a feature in which the lion cub differs not only from adult leopards, jaguars, and ounces, but also from adult lions.

If there is any truth in the above-stated assumption as to the origin of the tiger's pattern and also in the claim that the pattern of the lion cub is nearly intermediate in character between that of the leopard and that of the tiger—and I can see no strong argument against either,—it appears to me to be necessary to conclude that these three species of *Felis* are nearly related forms, a conclusion by no means obvious when the coloration of the adults alone is considered. It was largely no doubt owing to the differences in the coloration of the adults that each of these species has been referred to a distinct subgenus of the genus *Felis*.

I have elsewhere \* pointed out that the prevalent belief in near affinity between leopards and jaguars, so forcibly suggested by their patterns, is confirmed by the resemblance

\* P. Z. S. 1907, p. 677 (Oct.).



between the roars of the two species; and as an additional argument in favour of the view that lions and tigers are related, it may be urged that the roar of a tiger is sufficiently like that of a lion to be easily mistaken by those who have never noted the differences between the two sounds. The differences, of course, are obvious, but the similarity is also unmistakable. The roar of the tiger, in fact, is much more like the roar of the lion than it is like the roar of any other species of *Felis* that I have heard.

It is, in my opinion, quite evident that too much importance has been attached by earlier authors to *absence* of pattern in adult examples of some species of *Felis*. The lion and the puma, for example, are suggestively juxtaposed both in Jardine's monograph of this group, published in 1834, and in that of Dr. Elliot, published in 1883; and Trouessart, even as lately as 1904, kept the puma and the lion in the same subgenus. But if appeal be made to the primary pattern of these two species, as shown by the cubs, and not to the secondary coloration of the adult, which is probably of comparatively recent origin, very little support will be found for the view that the two are nearly related forms.

I have only had the opportunity of examining the skins of two newly born puma cubs, one in the collection of the Zoological Society of London, the other in the Museum of the Zoological Gardens at Clifton. Although the pattern of the two is in the main identical, they differ in certain respects so markedly from each other that it is probable that one or both of the parents of the one were specifically or subspecifically distinct from one or both of the parents of the other\*.

In the Zoological Society's specimen (Pl. XX.) the ground-colour is a brownish fawn, fading to white on the underside and on the inner side of the limbs. There is white above the eyes, on the upper lip, lower lip, and chin, the cheek below the post-ocular stripe being a dirty white. The sides and top of the muzzle are dark brown, and both the front and hind legs from the elbow and hock to the tips of the toes are also dark brown and without spots. On the side of the head a black stripe extends backwards from the corner of the eye beneath the ear, where it expands into a large dark patch. Above the inner corner of each eye a black stripe runs backwards on to the summit of the head, and between these are two narrower stripes. On the head these four stripes apparently become zigzagged and more or less broken up.

\* The puma (*F. concolor*) of the older authors has been divided into a number of species and subspecies of late years. It would be extremely interesting to know what the cubs of all these forms are like.

Unfortunately the hair on the posterior part of the head and the anterior part of the nape is rubbed off, so it is impossible to say for certain that the stripes extended right over this region. That they probably did so, however, is attested by the presence of four cervical stripes upon the posterior area of the nape. The admedians of these, though narrow and faint, can be traced on to the middle line between the shoulders. The externals, on the other hand, are broad and very distinct, the one on the right side being continued by a well-marked suprascapular stripe, a stripe which is persistent in so many of the smaller species of the genus *Felis*. On the sides of the neck outside the external cervical stripe there are some darker and fainter elongated spots or abbreviated stripes running downwards towards the throat and chest. On the shoulders below the suprascapular stripe there is also a large transversely elongated spot, and below this some smaller spots which become lost in the fuscous tint of the fore leg. On the lumbar and sacral regions of the body there are three very definite rows of large spots showing a decided tendency to coalesce into longitudinal stripes. On the sides of the body below the external of these (the dorso-lateral stripe) there are about three rows of large spots of irregular shape and sometimes more or less fused, especially on the abdominal region, where they tend to run into short zigzag abbreviated stripes. The thighs are spotted like the sides of the body. On the thoracic region, both dorsally and laterally, the spots are less symmetrically arranged than upon the abdominal region, and the posterior part of the thoracic region is marked dorsally with a pair of very large abbreviated stripes, representing two or three fused spots, and inclining obliquely backwards from a point close to the median dorsal line. The greater part of the tail is lost; but the one inch of its basal portion which persists exhibits a large dorsal spot.

The spots are all solid and of nearly uniform intensity.

The example in the Museum of the Clifton Zoological Society differs from the one above described principally in the complete absence of spots and stripes from the top of the head and the nape of the neck, in the tawny hue of the legs, and in the noticeably fainter tint of the spots on the sides of the body as compared with those of the dorsal area. On the head there is a short stripe above the inner corner of the eye, a narrow stripe descending backwards from the outer corner of the eye beneath the ear, and a brown patch above the corner of the mouth. The back of the ear is jet-black. Extending along the dorsal area from the shoulder to the root of the tail there are three rows of solid spots, those of the median or spinal row forming a more definite



line than those of the lateral row, which are about nine in number on each side. Below the latter the spots form roughly about three rows, but their arrangement is not obviously either vertical or longitudinal. On the shoulders the spots tend to run into abbreviated transverse bars; at least, on to the root of the tail the median spinal stripe extends. It expands along the tail into triangular blotches constituting transverse bars, about eight in number; the tip of the tail is black. The legs are practically without spots.

Broadly speaking, the pattern of the two specimens of puma described above agrees with that of the examples depicted in pl. ii. of Elliot's 'Monograph of the Felidæ.'

In the large size and small number of the spots, in their solidity and definite arrangement in three rather widely separated lines along the back, or, at least, along its lumbosacral area, in the nature of the markings on the tail, on the shoulders, and on the nape of the neck, when they persist there, the pattern of the puma is quite different from that of lions, leopards, jaguars, and ounces. On the evidence supplied by the pattern, the puma cannot, I think, be regarded as nearly related to any one of those species. Nor do I know of any special point, apart from size, in which the puma resembles the three spotted species just mentioned, while practically the only likeness he presents to the lion is the adult coloration, which must be set aside as a valueless criterion of relationship.

It is a very difficult matter to decide to which group of species of the genus *Felis* the puma is really related. The pattern is not like that of any existing form; but in the characters above enumerated, in which it differs from the pattern of leopards and lions, it approaches the pattern of several of the smaller species of the genus, species in which the pattern is, in my opinion, of a more primitive type than it is in the giants of the family.

I can find nothing in the structure of the skulls opposed to the view here put forward, that the puma cannot be associated with the group comprising tigers, lions, jaguars, leopards, and probably ounces, nor anything in disaccord with the suggestion that its nearest allies must be sought amongst some of the smaller species. Rather the contrary. And I do not think the resemblance between pumas and "domestic cats" in the ossification of the hyoidean suspensorium and in the expression of friendly feeling by "purring" should be altogether lost sight of in future discussions of the subject\*.

\* In lions, tigers, and leopards, according to Mivart, the suspensorium is ligamentous. These species do not "purr."

Summary.

1. The patterns of the cubs of lions and pumas are specific characters. These species, usually described as uniformly coloured, were formerly marked as their cubs are marked and in no other way.
2. The pattern of lion cubs is intermediate between the spotted pattern of leopards or jaguars and the striped pattern of tigers.
3. From this it may be inferred that leopards (including jaguars), lions, and tigers are nearly related one to another.
4. On the assumption that spots preceded transverse stripes in evolution, it may also be inferred that the stripes of tigers originated from the fusion of rosettes into transverse chains, as Dr. Bonavia maintained.
5. The pattern of puma cubs affords no support to the belief that pumas are nearly allied either to leopards or lions.
6. Rather, in my opinion, does the pattern of puma cubs suggest that pumas may be regarded as large self-coloured representatives of one of the groups of smaller species of *Felis*, in the same way that lions may be regarded as large and otherwise modified representatives of a group exemplified by leopards.

EXPLANATION OF THE PLATES.

PLATE XIX.

Copy of a photograph of the dorsal view of a mounted lion cub in the collection of the Bristol Museum, showing the formation of transverse stripes from rosettes and attesting the relationship between lions and leopards on the one hand, and lions and tigers on the other.

PLATE XX.

Drawing of the flat skin of a newly born puma cub in the collection of the Zoological Society of London. The unshaded area on the fore part of the neck shows where the hair has been rubbed away. Since the tail was absent from this skin, the drawing of that organ was copied from the example in the Museum of the Clifton Zoological Gardens.

LXIII.—*Descriptions and Records of Bees.*—XVII.

By T. D. A. COCKERELL, University of Colorado.

*Osmia fulgida*, Cresson, 1864.

THIS species was described from the female. Mr. S. A. Rohwer collected five males at Florissant, Colorado, June 15 to July 6, 1907; one was at flowers of *Erigeron*. The male is about 9 mm. long, very bright green, the abdomen shining;